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PHENETICAL INVESTIGATION ON SOME TAXA OF GENUS *Vicia* (FABACEAE).

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ABSTRACT

The objective of this investigation is to clarify the relationships among some taxa of genus *Vicia* (representing 3 different sections) namely; *V. narbonensis* var. *jordanica*, *V. narbonensis* var. *affinis, V. johannis* and *V. faba* var. *major* (section *Faba*); *V. anatolica* (section *Hypechusa*) and *V. sativa* var. *sativa* (section *Vicia*), through analysing the morphological characters using the cluster analysis technique. Characters were scored on 70 herbarium specimens and 90 fresh plants representing the studied taxa.

Results of the phenetical analysis reveal that, within section *Faba*, both varieties of *V.narbonensis* were more close to each other than to the other two taxa of the same section; *V.johannis* and *V.faba* var.*major,* by sharing many characters, *i.e.* stipule entire shape, tendrillous leaf apex, purple standard petal, violet wing petal, spherical and brown seed and oval hilum shape. *V.faba* var.*major* was very distinct taxon and characterized by some unique characters did not found in other taxa, *i.e*., translucent stipule, mucronate leaf apex, white standard, white wing with black spots, oblong seed shape, round and black hilum. These characters lead this taxon to be a very recognized species within section *Faba*. Taxa of the other two sections have also some characters varied between each other and with the taxa of section *Faba*. These characters, which ranked these taxa in separate sections, are branched tendrillous leaf apex, spherical to round seed shape, yellow-brown seed colour and elongated hilum shape (in *V.anatolica*). While, *V.sativa* var.*sativa* has mucronate to slightly tendrillous leaf apex, ellipsoid seed shape, matt seed out look, elongated to oval hilum shape and yellow colour of hilum groove.

INTRODUCTION

The genus *Vicia* L. (Vicieae, Fabaceae) comprises 166 species (Alkin *et al*., 1986), chiefly located in Europe, Asia and North America, and extending to temperate South America and tropical Africa. The genus was revised by Kupicha (1976). Who commented that; *Vicia* species have been grouped into four main species clusters; *Cracca, Vicia, Ervum* and *Faba. Vicia* contains species agriculturally important; Faba bean (*V.faba* L.), common or field vetch (*V.sativa* L.), narbon vetch (*V.narbonensis* L.) and their close wild relatives, such as *V.johannis* (Stankevich, 1983 and Tzvelev, 1980).

The description of genus *Vicia* as provided by Kupicha (1976) is as follows: “Annual or perennial plants. Leaves hypostomatic to hypo-amphistomatic, paripinnate, usually tendrillous, occasionally mucronate; stipules monomorphic, always with a glandular nectariferous pit on the abaxial side. Inflorescence one to several flowered, peduncle very rarely longer than subtending leaf, commonly shorter than the flower, flower sometimes sessile. Calyx regular or irregular Vexillum platonychioid or stenorychioid, rarely pubescent on abaxial surface. Style with hairs all round

apex or only on abaxial side, always tufted abaxially. Legume not stipitate, containing ± well-developed "woolly" parenchymatous tissue between seeds; pods oblong, rhomboidal or linear. Seeds with long to short hila, testa smooth or rarely rough; lens near hilum or on opposite side of seed. Canavanine absent".

The general aim of this study is to clarify the relationships among taxa from different sections on genus *Vicia* using the available morphological characters.

MATERIALS AND METHODS

The current investigation was carried out during seasons 2000/2001and 2001/2002. Seeds of the wild taxa of different sections were received from the Gene Bank of Biology Department, Southampton University, U.K. Seeds of the cultivated taxon; *V.faba* var. *major*, were obtained from the Agronomy Department, Faculty of Agriculture, Cairo University, Giza, Egypt. Seeds were sown on 10 th October 2000 and at the same date on 2001, in green house of Botany Department, Faculty of Agriculture, Cairo University, in plastic pots, 30 cm in diameter filled with Jiffy 7 pet pellets at 5 seeds per pot, and 5 pots per taxon. The plants were kept till maturity to collect fresh plants for morphological (phenetical) analysis.

For the phenetical investigation 70 herbarium specimens (Table 1) representing the studied taxa were examined. Specimens were borrowed from BM, K, E, SPN and CAI (abbreviations follow Holmgren *et al.*, 1990) and this material was used in conjunction with 90 fresh plants (3 plants from each pot of each taxon) collected from the above growing seeds. Each specimen was scored, where possible, for 75 variable characters, these includes 25 vegetative, 20 inflorescence, 15 legume and 15 seed features. These characters were selected from the literature (Plitmann (1967); Ball (1968); Davis & Plitmann (1970) and Kupicha (1976)) and from personal observations on the specimens. The characters and character states used in this study were listed below in Table (2). The data were analyzed using the program called LINKAGE (Wirth *et al.*, 1966). The program uses only those characters for which data is present and ignoring the missing data.

Table (1): List of *Vicia* taxa included in the study.

Taxon	Code	Authority	Locality	Section
V.faba var. *major*	1-5 6-10 11-15 16-20	Linnaeus C.	Spain Guatemala S.America Portugal	*Faba*
V. narbonensis var.*jordanica*	21-25 26-30	Schäfer H.	France Spain	*Faba*
V.narbonensis var. *affinis*	31-35 36-40	Korn.exAsch & Schweinf	Belgium Turkey	*Faba*
V.johannis	41-45 46-50	Tamamschjan	Turkey Cyprus	*Faba*
V.anatolica	51-55 56-60	Turrill	Turkey Syria	*Hypechusa*
V.sativa var.*sativa*	61-65 66-70	Linnaeus C.	Spain France	*Vicia*

Table (2): List of morphological (phenetical) characters and character states used in the study.

No.	Characters	Characters states
1	Life form	Annual, perennial
2	Growth habit	Erect, ascending, procumbent
3	Plant height mm	
4	Stipule shape	Entire, semihasitate, semisaggitate, lanciniate
5	Stipule edge	Translucent, not translucent
6	Stipule colour	Green, green with purple, purple
7	Leaf length mm	
8	Petiole length mm	
9	Leaflet length mm	
10	Leaflet width mm	
11	Tendril length mm	
12	Petiolule length mm	
13	Leaf apex	Mucronate, tendrillous, terminal leaflet
14	Upper leaflet margin	Entire, serrate, lobed
15	Lower leaflet margin	Entire, crenate
16	No.of leaflets per leaf	
17	Leaflet shape	Linear, elliptic, ovate, oval
18	Leaflet apex shape	Retuse, mucronate, emarginated, acute, obtuse
19	Leaflet distribution pattern	Unpaired, paired
20	Leaflet adaxial hair density	Absent, more
21	Leaflet adaxial hair length mm	
22	Leaflet abaxial hair density	More, less
23	Leaflet abaxial hair length mm	
24	Petiole hair density	More, less
25	Stem node colour	Green, purple, green/purple
26	Peduncle length mm	
27	Flower length mm	
28	Ratio of peduncle to flower mm	
29	No.of flower/inflorescence	
30	Calyx tube length mm	
31	Calyx base shape	Not gibbose, slightly gibbose, strongly gibbose.
32	Calyx tube shape	Truncate, oblique
33	Calyx teeth reflexing	Absent, present
34	Calyx exterior nectarines	Absent, present
35	Calyx hair distribution	Absent, on teeth, general coverage
36	Calyx colour	Green, purple, purple teeth, green/purple
37	Standard length mm	
38	Standard face colour	Creamy, white, yellow, pink, lilac, violet, purple
39	Standard back colour	As above
40	Standard shape	Platonychioid, stenonychioid
41	Wing colour	White, creamy, yellow, pink, lilac, violet, purple
42	Wing length mm	
43	Wing spot colour	Brown, black, purple, inapplicable
44	Wing shape	
45	Keel shape	
46	Ovary length mm	
47	Style length mm	
48	Ovary shape	Linear, intermediate, oblong
49	Stigma shape	Globose, conical, discoid
50	Ovary pubescence	Glabrous, sutures only, all coverage
51	No.of ovules/ovary	
52	Legume length mm	
53	Legume colour	Yellow, brown, black
54	Legume cobration	Uniform
55	Legume shape	Linear, rectangular, oblong
56	Legume surface	Smooth, ridged
57	Legume venation	Absent, reticulate, longitudinal
58	Legume hair position	Inapplicable, sutures, all coverage
59	No. of seed/legume	
60	Legume twisting	Loose, tight
61	Seed length mm	
62	Hilum length mm	
63	Seed shape	Spherical, cubical, ellipsoid, oblong
64	Seed shape in side view	Laterally compressed, not laterally com.
65	Seed colour	Yellow, brown, black, black/brown

Table (2 cont.): List of morphological (phenetical) characters and character states used in the study.

66	Seed out look	Shiny, matt, variable
67	Seed surface	Smooth, tuberculate, pitted
68	Hilum shape	Round, oval, elongated, erect
69	Hilum surface profile	Convex, concave
70	Hilum colour	Yellow, brown, black
71	Colour of Hilum groove	Yellow, brown, black, dark brown, red brown, beige, white
72	Hilum position	End, corner, side
73	Lens position	Opposite hilum, confluent to hilum
74	Colour of center strip of hilum	White, red brown, beige
75	Lens colour	Yellow, brown, black, varied

RESULTS AND DISCUSSION

Throughout the results presentation, taxa will be identified using numerical codes and symbols, which indicate the sections to which each taxon belongs (Table 1). The interpretation of the linkage diagram requires introduction. At any similarity level each pair of taxa will link and this is demonstrated in the diagram by a line connecting them. This connecting line occurs in three kinds: a single line indicating relationship already established at a higher level of similarity, a double line indicating a new relationship established at that certain similarity level and a broken line which indicates a new internal (within cluster) link at that similarity level. To simplify interpretation of the diagrams, highly inter-connected cluster are encircled. The criterion for inclusion in a circle is that each taxon should has at least three links with other members of the same cluster.

The linkage diagram in Fig. (1) shows twelve clusters of taxa. At that similarity level (0.03), nine clusters are referable to section *Faba*; two clusters to *Hypechusa* and one cluster to *Vicia*. Each cluster contains the taxa of the same section, which are very similar and mostly close to each other. All specimens of *V.faba* var. *major* from different locations were linked together, except those from Portugal (coded 16 to 20), which will link at similarity level 0.05. Although the specimens from Guatemala (coded 6 to 10) belonging to *V.faba* var.*major*, they are remaining as isolated specimens from the other *V.faba* var. *major* till the last level of similarity. The reason for that is inapplicable.

Clusters of section *Faba*, which include the wild taxa, all the specimens of *V.narbonensis* var.*affinis* from Belgium were linked in one cluster and have a new relationship with the specimens from Turkey, which at level 0.04, specimens of both locations were linked in one large cluster. Specimens of *V.narbonensis* var.*jordanica* from Spain were linked also at level 0.03 separately from those of France. The two clusters of section *Hypechusa,* which includes specimens of *V.anatolica* were linked separately at this level and started to link together in the next level of similarity. The cluster of section *Vicia*, which include specimens of *V.sativa* var.*sativa,* remaining as a separate cluster till level 0.07, when it starts to link with the cluster of section *Hypechusa*.

The next linkage diagram (Fig. 2), similarity level 0.04, shows the linking of the clusters; one encircled cluster contain 10 specimens of *V.narbonensis* var.*affinis*, two encircled clusters of *V.faba* var.*major* specimens (coded 1-5 & 6-10), one encircled cluster of *V.anatolica* linked through specimens coded 56 to three specimens of the same taxa coded 52, 54 and 55. The rest of the clusters still without any obvious change from the previous level.

At similarity level 0.05 (Fig. 3), there are nine clusters; three encircled clusters included 15 specimens of *V.faba* var.*major* and the other specimens link in separate cluster, one encircled cluster of 10 specimens of *V.anatolica*, one cluster of 9 specimens of *V.johannis* and the tenth specimens (coded 41) has three links with them, one cluster of all the specimens of *V.narbonensis* var.*affinis* started to link with the clusters of *V.narbonensis* var.*jordanica* through the specimens coded 23 and 29 and finally two separate clusters of *V.sativa* var.*sativa*.

Fig. (4) shows the similarity at level 0.06, where the cluster includes the specimens of *V.faba* var.*major* (coded 2, 4 and 5) has three links with a specimen coded 12 in the other cluster as step to be in one large encircled cluster at the next similarity level. In addition, the specimen of *V.faba* var.*major* coded 16 links with three specimens (coded 11, 13 and 14) of the other encircled cluster. Meanwhile, the cluster includes specimens from Guatemala still as isolated encircled cluster. At that level also, the specimens of *V.sativa* var.*sativa* coded 62, 63 and 64 have three links with a specimen coded 70 of the same taxon. Specimens of *V.narbonensis* var.*affinis* and *V.narbonensis* var.*jordanica* become in one large encircled cluster, the same occurred with the specimens of *V.anatolica*

At similarity level 0.07 (Fig. 5) new relationships recognized, between the cluster includes specimens of *V.johannis* (coded 41, 42, 43 and 50) and the cluster includes both varieties of *V.narbonensis,* through the specimens of *V.narbonensis* var.*affinis* (coded 32, 35, 36 and 40) as a step to be in one large cluster at the next level. At level 0.07, the cluster of *V.anatolica* specimens has a new relationship with the cluster of *V.sativa* var.*sativa* specimens (coded 58, 59 and 60) through the specimen coded 61.

Fig. (6) shows the similarity at level 0.10, where all the specimens of *V.anatolic*a and *V.sativa* var.*sativa* become in one large cluster. In addition, all the specimens of *V.faba* var.*major* (except those from Guatemala) sharing in one large cluster. This cluster starts to have a new relationship through specimens coded 20 with the cluster includes specimens of *V.johannis* and both varieties of *V.narbonensis*.

At similarity level 0.13 (Fig. 7), all the specimens of *V.narbonensis* var.*jordanica* and *V.narbonensis* var.*affinis*, *V.johannis* and *V.faba* var.*major* (except those from Guatemala) become in one main cluster. They started to have a new relationship through specimen (coded 31) with some specimens of *V.anatolica* (coded 51, 52 and 53) and through specimen (coded 41) with specimens of *V.sativa* var.*sativa* (coded 61, 67 and 70) to become in one cluster at the next similarity level. The cluster of Guatemala specimens starts to have a new relationship with the main cluster through the specimen (coded 9).

fig1,2,3

fig4,5

fig6,7

fig8

In the last level of similarity 0.20 (Fig. 8) all the specimens representing the studied taxa become in one large cluster. The linkage cluster analysis dendrogram for the studied taxa represents in (Fig. 9).

The previous phenetic results were in accordance with those obtained by Maxted *et al.* (1991); Plitmann (1967) and Khattab (1987) on taxa from different sections of genus *Vicia*.

fig9

CONCLUSION

Referring to the phenetic results and from the morphological features varied among taxa of genus *Vicia* (Table 3), it could be concluded that:

table3

V.faba var.*major* is considered a distinct and isolated taxon, by its unique characters, from the other wild taxa either in section *Faba* or in the other sections. *V.anatolica* and *V.sativa* var.*sativa*, separately, are considered as distinct taxa, which differ from all wild and cultivated taxa of section *Faba*, so they ranked in different sections. Both varieties of V.narbonensis; var.*jordanica* and var.*affinis*, in addition to *V.johannis*, were overlapping in many of the studied characters or there was no much difference among them. For these reasons, these taxa were either ranked under *V.narbonensis* complex (Plitmann, 1976 and Cubero, 1982) or as separate taxa in the same section (Kupicha, 1976, Khattab, 1987 and Maxted *et al*., 1991).

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ملاحظات مظهرية على بعض الفئات التصنيفية من جنس الفول *Vicia* (الفصيلة البقولية).

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تهدف هذه الدراسة الى اظهار العلاقات المظهرية بين بعض الفئات التصنيفية من جنس الفول *Vicia* والتى تنتمى الى ٣ قطاعات مختلفة وهى:

- *V.narbonensis* var.*jordanica*, *V.narbonensis* var.*affinis, V.johannis* and *V.faba* var.*major* وتتبع قطاع *Faba*
- *V.anatolica* وتتبع قطاع *Hypechusa*
- *V.sativa* var.*sativa* وتتبع قطاع *Vicia*

من خلال التحليل المظهرى للصفات المورفولوجية باستخدام طريقة التحليل العنقودى. وقد سجلت الصفات المورفولوجية على العينات النباتية المجففة (٧٠عينة) الممثلة للفئات التصنيفية تحت الدراسة بالإضافة آلي النباتات الحية (٩٠ عينة) التى تم جمعها واختبارها من تجربة الصوبة.

أظهرت نتائج التحليل العنقودي للصفات المورفولوجية للفئات التصنيفية بقطاع *Faba* أن الصنفين للنوع *V.narbonensis* كانا الأكثر تقارباً لبعضهما البعض عنة الى *V.faba* var.*major* أو*V.johannis* داخل نفس القطاع نظرا لاشتراكهما فى العديد من الصفات مثل شكل الاذينات كاملة الحواف- قمة الورقة المحلاقية – بتلة العلم والجناح بنفسيجية اللون – البذرة مستديرة وبنية اللون والسرة بيضية الشكل. كان الصنف *V.faba* var.*major* أكثر الفئات التصنيفية تميزاً واتصف ببعض الصفات الفريدة والتى لم توجد فى أى فئة تصنيفية أخرى بنفس القطاع مثل شفافية الاذينات – قمة الورقة المستدقة – بتلة العلم بيضاء – بتلة الجناح بيضاء ذات بقعة سوداء – البذرة بيضاوية والسرة سمراء مستديرة. تميز النوعان الاخران بالقطاعات *Vicia* and *Hypechusa* بالعديد من الصفات المختلفة بينهما البعض وبين الفئات التصنيفية بقطاع *Faba*. من هذة الصفات قمة الورقة محلاقية متفرعة – شكل البذرة مستدير الى كروى – البذرة بنية اللون والسرة مستطيلة كما فى النوع *V.anatolica*. بينما تميز الصنف *V.sativa* var.*sativa* بقمة الورقة المستدقة الى المحلاقية – البذرة مضغوطة والسرة بيضية الى مستطيلة وذات أخدود مركزى أصفر.